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The Editor wishes to learn of a 2 or 2½ inch refractor, preferably on a tripod, for sale.

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ROYAL ASTRONOMICAL SOCIETY

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VOL. XIV MAY, 1920 No. 4

SUNLIGHT ENGINEERING IN RELATION TO HOUSING AND TOWN PLANNING*

BY H. L. SEYMOUR

First, I wish to mention some well known facts about the sun and then I hope to show you that they should be considered in determining the direction and width of streets, the height, orientation and density of buildings, and similar matters of more or less importance in planning. I believe I am correct in stating that it is only recently that the application of such facts has been a matter of careful study.

How much weight should be given to this question of sunlight must be a matter of judgment in each case; there may be factors or conditions that make it of small importance. But in some instances it is of great importance and in general to the town planner is given the problem of the scientific utilization of sunlight in his lay-out of streets and buildings.

For the purpose of this paper I propose to divide the light derived during the day into (*a*) daylight or skylight, and (*b*) sunlight; with the latter we are mostly here concerned. "Skylight comes from all directions of the heavens; sunlight from only one direction, constantly varying with the revolution of the sphere".†

*Abridgment of a paper presented at the Ottawa Centre of the Royal Astronomical Society of Canada. The paper was illustrated with diagrams and lantern slides.

†Atkinson, "Orientation of Buildings," to which work I am indebted for much of the information in this paper.

The astronomer has been searching the heavens with telescopes of ever increasing size and power to bring to our knowledge far distant heavenly bodies. A similar search has been made by the bacteriologist with high-powered microscopes of also ever increasing magnification. These now disclose many small forms as cleverly hidden from us in the past as were the distant stars. Just as the astronomer feels certain that there are many bodies which he has not yet seen so is it with the bacteriologist in his work. The latter, however, generally has various means of verifying his presumptions, —for example, that of letting a bacterium indiscernible with the microscope, produce under favourable conditions a colony of such proportions that it is readily seen by the naked eye.

Some of these bacteria are beneficial to us, but others are not so friendly. Every contagious and infectious disease is caused as a rule by a specific bacterium or similar organism. Now the oxidizing action of direct sunlight and its accompanying drying properties are the greatest natural agencies in destroying disease or pathogenic bacteria. This point I wish to emphasize because I feel that in the final analysis, it is the strongest scientific argument that can be advanced, as far as housing is concerned, for direct sunlight. In a cubic metre of air taken from over the ocean there was found only one bacterium. In the same amount of air taken from a Paris hospital there were 79,000 bacteria. In the open air of the country there are many less than in the city air, which, as a rule, is shut off from direct sunlight.

"Second only to air is light and sunshine essential for growth and health, and it is one of nature's most powerful assistants in enabling the body to throw off these conditions which we call diseases. Not only daylight but sunlight; indeed fresh air must be sun-warmed, sun-penetrated air. The sunshine of a December day has been recently shown to kill the spores of the anthrax bacillus" (*Healthy Hospitals*, Sir Douglas Galton, Oxford, 1893). This latter is no mean performance when one remembers that bacterial spores or "seeds" are protected with a hard casing which renders them much more difficult to destroy than the parent bacteria. The figures given for the duration of life of the tubercle bacilis are as follows:

Dark Places	2-18 months
Diffuse daylight	6-24 hours
Sunlight	10 min -1 hr.

Besides being nature's great preventative for the spread of disease we all have felt the exhilarating effect of sunlight and know its general effect on public health and sanitation.

"Unquestionably one of the first requisites for a healthy building is abundance of sunlight. Not only the exterior wall surfaces of the buildings but also the surface of the ground around them should have the direct rays of the sun for as long a time as possible each day" says Atkinson. The amount of sunlight that may actually enter into rooms by the windows set in the walls is also of great importance and mostly so in the winter when windows are closed and there is not possible a circulation of air that has been sun-purified outside the building.

I assume that you agree with these conclusions and will pass on to the considerations of the

Astronomical Data.

Atkinson has prepared for Latitude 42° N. a diagram showing the apparent path of the sun for different months in the year. The condition of the winter solstice may be considered as fairly typical of the period of the four months from October 21st to February 21st. For the northern climes this is the period for which special planning is necessary as can be judged from the following reasons, with which you are all very familiar but which will bear some elaboration.

1. *At the winter solstice the days are the shortest*, which means that the total possible amount of sunlight that can be received per day is the least in the year. A nomogram has been prepared in the Surveyor General's office from which the duration of sunlight in Canadian latitudes can be quickly determined.* The effect of latitude on the length of the day is readily apparent:

	Lat.	*Duration of Sunlight*
At the summer solstice.....	42°	15.25 hours
	60°	18.90 "
At the winter solstice.....	42°	9.10 "
	60°	5.85 "

*See "Nomogram Showing Duration of Sunlight," by W. H. Herbert in the October, 1919, issue of this JOURNAL.

2. *At the winter solstice the sun's rays are most oblique.* For example, at noon, December 21st, the altitude of the sun is only about 15° at London, England (Latitude 51½° N.), which is but little north of Calgary, Alberta.

As you know, the intensity of heat and light received from the sun is greatest as the rays become most nearly vertical. We find then that not only the total amount but also the intensity of the sunlight received in winter is less than that received in summer. That we should plan to conserve all the sunlight we receive in the northern climes in the winter is the obvious conclusion. If we do this we shall be amply rewarded.

3. *At the winter solstice the shadows cast are the longest and cover the greatest area.* In this connection some facts are of interest as to some of the New York skyscrapers. These facts and others in this paper are taken from recent papers by Messrs. Swan and Tuttle on "Planning Sunlight Cities" and "Sunlight Engineering in City Planning and Housing":

> At noon, December 21, the Woolworth Tower, 791 feet high, casts a shadow of 1,635 feet in length.
>
> The Equitable Building at the same time, being 493 feet high, with a ground area of 1.14 acres, casts a shadow 1,018 feet long, covering an area of 7.79 acres, with the result that the fronts or facades of many tall buildings are completely shaded all day.
>
> The street on the north of the Equitable Building is 34 feet wide. If this north and south street were built up of Equitable Buildings then "not a single window within 447 feet of the street level would receive a ray of direct sunlight on December 21.

At noon on December 21st the altitude of the sun is at the places named approximately as follows:

At the Equator	66.6°
At Winnipeg	16.6°
At Edmonton	13.0°

On east and west streets if the whole south front of buildings on the north side are to receive sunlight at noon December 21st, then the width of the street must be:

At Equator	0.43	times the height of buildings on south side
At Winnipeg	3.33	" " " " " "
At Edmonton	4.33	" " " " " "

Or the shadow cast at Winnipeg is in length 7.77 times that at the equator; at Edmonton 10 times that at the equator (at noon, winter solstice).

As the condition at the winter solstice is evidently the most unfavourable for sunlight planning and because, as shown, such condition obtains to a great extent from about the middle of October to late in February, this condition should be the one to receive the greatest study. If ample sunlight can be provided for this period of four months, our problems are, with few exceptions, solved.

Orientation of Detached Buildings.

How should a detached building be constructed and oriented so that not only the exterior wall surfaces but also the surface of the ground around them have the direct rays of the sun for as long a time as possible on December 21st?

Investigation shows that by orienting our building with sides, northeast, southwest, etc., every side receives sunlight, except in the far north; and that for a detached building this position is preferable. This has been recognized in Switzerland, where cottages have their diagonals square with the cardinal points.

The matter of orientation is considered an important one for hospitals. The Central Alberta Sanitarium near Keith, Alberta, is a good example.

Orientation of Buildings in Rural and Residential Developments.

Having found the best orientation for an isolated detached building, the next matter is to determine the effect of the grouping of buildings. Until the shadows cast by adjoining buildings are such that all sunlight is cut off from some surface of the building under consideration, or until there results a ground area or areas of perpetual shadow there would appear to be no advantage in changing the orientation of buildings considered favourable for isolated conditions. It can be shown that buildings on a north-south street must be much further apart than on a northwest-southeast or a northeast-southwest street. It would appear then that streets in an open rural or residential development and where no important factor dictates otherwise, should preferably be placed so that buildings thereon and with faces parallel thereto, have their sides at an

angle of 45° with the cardinal points. This means that streets in such a development should run northeast-southwest and northwest-southeast and not north-south and east-west as is the general custom. Kipawa, Quebec, is an actual case in course of development, having been planned by Mr. Thomas Adams, Dominion Housing and Town Planning Adviser.

Orientation of Attached Buildings.

Writings in 1864, Horace Bushnell in his essay on City Plans (*Work and Play*) said:

> It is also a great question; as respects the health of the city, in what direction, or according to what points of the compass, the streets are to be laid. To most persons it will appear to be a kind of law that the city should stand square with the cardinal points of the compass—north, south, east and west, and where this law appears not to have been regarded how many will deplore so great an oversight, and even have it as the standing regret of their criticism. Whereas, in the true economy of health and comfort, no single house or city should ever stand thus, squared by the four cardinal points, if it can be avoided. On the contrary, it should have its lines of frontage northeast, southwest, northwest and southeast where such disposition can be made without injury in some other respect; that so the sun may strike every side of exposure every day in the year, to dry it when wet by storms, to keep off the mould and moss that are likely to collect on it, and remove the dank sepulchural smell that so often makes the tenements of cities both uncomfortable and poisonous to health.

Mr. Bushnell has applied the considerations that affect single buildings and open development to the conditions of close or urban development. With this conclusion Atkinson also agrees. It will now be my endeavour to show whether or not Atkinson is justified in such conclusion.

Atkinson has prepared "shadow curves" for latitude 42° N. at the solstices and equinoxes for a height of attached buildings of one and one-half times the space between rows. This space is in many cities the width of the street, no set-back being insisted on. Mr. Atkinson states in his "Orientation of Buildings":

> In the north-south street the distribution is symmetrical, the buildings on either side receiving an equal amount. On the east-west street the north face of the street receives no sunlight during six months of the year, and the buildings on the south side are in perpetual shadow during the same period. In planning towns the east and west street should be avoided as far as possible, and where

unavoidable, the buildings should be of moderate height and built in detached blocks. In the checkerboard plan the best distribution of sunlight is obtained when streets run northeast-southwest and northwest-southeast.

Mr. Atkinson might have added that his diagrams for latitude 42° N. show that a street and the attached buildings fronting thereon will receive most sunlight at the winter solstice when the street is oriented north and south

Messrs. Swan and Tuttle, previously referred to, have apparently approached the whole matter of sunlight illumination from a different angle—not emphasizing a study of detached buildings as Atkinson has done, but laying particular stress on the consideration of developments carried out on New York lines, where closely placed or contiguous high buildings face only on the main and not, to any extent at least, on the cross streets. They conclude that the main street will receive most sunlight when it is oriented north and south. This conclusion is supported by many useful tables prepared for latitudes from 25° N. to 60° N though only at the winter solstice (the period most adverse for sunlight planning in northern latitudes). And it is shown that while no sunlight may be received all day on an east-west street as far south as Latitude 30 yet in Latitude 50 N., under the same conditions, a north-south street receives over an hour of sunlight.

Blocks improved with houses in rows or with apartment houses, then, should have their length parallel to north-and-south streets and their breadth parallel to east-and-west streets.

Swan and Tuttle also recommend that

Blocks the length of which parallels east-and-west streets should be subdivided into lots fronting on minor north-and-south streets laid out across the narrow dimensions of the block before they are improved with attached houses.

Though long narrow blocks are common, it has been contended that in some cases such a development is neither economical nor desirable and blocks more nearly square are to be preferred.

Assume for a "square" block development, buildings to be attached in rows, to be in height one-half the width between these and similar buildings on opposite sides of the street, and to be located in Winnipeg, latitude 50° N. Then we find from Swan and Tuttle's tables that on December 21st, houses near the centre of

the sides of the block (or sufficiently far from street intersections to be uninfluenced thereby) will have their fronts exposed to direct sunlight as shown in Table I.

TABLE I

N-S, E-W Orientation				N.E.-S.W. Orientation			
Side	Total time on street facade	Time cut off by window	Net time entering room	Side	Total time on street facade	Time cut off by window	Net time entering room
North.....	0		0	Northeast...	0h 22m	all	0
East.....	1h 52m	0h 50m	1h 1m	Southeast...	2 39	1h 1m	1h 38m
South.....	0		0	Southwest..	2 39	1 1	1 38
West.....	1 52	0 50	1 1	Northwest..	2 39	all	0
Total	3h 44m		2h 02m	Total	6h 02m		3h 16m

The amoun of sunlight that may shine on the rear of houses will vary with the size of the open space in the interior of the block as well as on account of the orientation of the blocks. But with the N.-S., E.-W., orientation there is a southerly row of houses which receives no sunlight on either the front or rear elevations nor in any rooms. With the other arrangement every house is sure of having at least one of its facades sunlighted, and sunlight can enter the rooms, if not from the front then from the rear.

With the northeast, southwest, orientation all the streets circumscribing the block receive some sunlight, while in the first arrangement there are two unlighted streets. If then the square block developed with attached houses is for sufficient reason considered desirable it should evidently be oriented with streets at an angle of 45° with the cardinal points for the conditions stated, though as the height of buildings and latitude increase the advantages disappear.

The foregoing may be considered more of academic than of practical interest, but it at least draws attention to the conclusions arrived at by all authorities, that if east-and-west streets are to be built upon buildings should be detached.

Consideration of the arrangement of windows and the disposition of rooms are important but reference must be made to the authorities already named.

We find then differences of opinion. If we agree with Atkinson, that for isolated buildings and for rural or open residential development the northeast-southwest orientation is generally to be preferred, we do not have to follow him when he concludes, with but little investigation, that city streets with intensive development should be oriented in a similar manner. We must also remember that Atkinson has considered only a latitude of 42° N. though giving us diagrams for the equinoxes and solstices. If we agree with Swan and Tuttle from a consideration of their numerous and comprehensive tables that city development should generally take the form of long narrow blocks with the main streets north and south we do not have to apply that conclusion to the single detached house or rural development in ordinary latitudes.

From what little study I have made of the subject of sunlight illumination in relation to housing and town planning, I am impressed with the fact that the detached building and open development offer us a different problem from attached buildings and intensive development. In the first case there are four sides of a building on which sunlight might enter, in the other only two and those on opposite sides. In the one case we have generally only to consider the amount of sunlight cut off from walls and site by the walls of the building itself, while in the second case we are concerned mainly with the shadows cast by obstructing buildings on the opposite side of the street or by another row of buildings at the rear.

General Conclusions.

A. *Detached Buildings.*

1. Isolated detached buildings should be constructed with their walls not square with the cardinal points of the compass but at an angle therewith—preferably 45°.

2. Detached buildings as usually grouped in rural and residential districts should be oriented as in (1), the streets on which they face running northeast-southwest and southeast-northwest.

B. *Attached Buildings.*

1. Long narrow blocks with high buildings should have their lengths on streets running north and south, and these conditions are suited to intensive city development.

2. Square blocks, with low attached buildings, should usually be oriented so that streets make an angle of 45° with the cardinal points.

3. Houses fronting on east-and-west streets should, if possible, be detached.

C. *Disposition of Rooms and Windows.*

1. As a rule attached houses, when fronting on east-and-west streets require a greater frontage than houses on a north-and-south street.

2. In general the disposition of rooms and windows should be planned in relation to the orientation of the building.

D. *Height of Buildings and Width of Streets.*

1. There is an intimate relation between the height of building and the width of street; and this relation must receive consideration particularly in high latitudes.

2. To illustrate the above conclusion and because of its general interest I submit a paragraph from "Rural Planning and Development" by Thomas Adams:

> Heights of building should have some relation to the width between buildings, in rural areas a low standard of height can be fixed with advantage to owners of land. This is needed not only to secure light and air, but to prevent traffic congestion in the suburbs in towns and on rural territory surrounding them. We should determine the question of light and air to buildings by fixing a minimum distance between all buildings on opposite sides of streets without regard to the width of the street itself, by limiting the amount of land in the subdivision which should be occupied by actual building and by requiring a minimum angle of light to all windows. Apart from special cases, where the evil of high buildings has already been established, no buildings should be higher than the width of the streets facing them, and rural municipalities at least have power to adopt this standard. Ample justification can be given from every point of view, including that of the interests of real estate, for such a limitation.
>
> For desirable results the street plan and building plan should not be considered separately but "must be conceived and perfected in harmony."

Ottawa, Ont.

A POSSIBLE EXTENSION OF THE CALCIUM ENVELOPE HYPOTHESIS

W. Carl Rufus

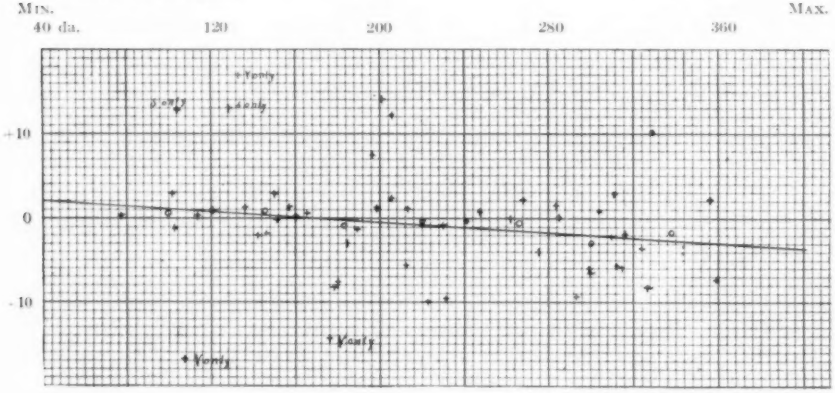
The calcium envelope hypothesis to explain the small velocity range determined by the *H* and *K* lines of calcium in certain spectroscopic binaries may be extended and tested for other high-level elements, *e.g.*, hydrogen. The hydorgen envelope, presumably occupying a lower level than the calcium, would not be expected to show such a great difference in velocity range from the mean value; but we may expect to find cases in which a smaller range is indicated by the hydrogen lines than by the heavier elements.

χ Aurigae* affords a good opportunity to make a simple comparative test. Only two hydrogen lines $H\gamma$ and $H\delta$, entered in the radial velocity determination, so their effect upon the form of the velocity curve is not great compared with the eleven lines of helium, silicon, carbon and magnesium. We may therefore directly compare the mean radial velocity, V_m, determined by the use of the thirteen lines as given by Young, with the velocity V_h, determined by the hydrogen lines alone, observing the assigned weights. The 88 plates give a set of 88 values of V_m and a corresponding set of values of V_h. The 88 residuals, $V_h - V_m$, should show a systematic distribution when arranged with respect to phase, provided the velocity range determined by the use of the hydrogen lines alone differs appreciably from the mean.

Using time intervals as abscissae and the residuals as ordinates a test for systematic distribution was made with very interesting results. Rejecting a few discrepant values depending upon only one hydrogen line the residuals are well distributed with reference to a curve about two kilometers higher at minimum velocity and three kilometers lower at maximum than the zero residual axis.

*Orbit of the Spectroscopic Binary χ Aurigae: R. K. Young, Pub. of Dom. Obs. Vol. IV., No. 1, 1916; This Journal **10**, 358, 1916.

In terms of velocity range this indicates that the range determined by hydrogen alone is five kilometers less than the mean. As the observed difference is about one-eighth the mean value, 41 kilometers, it appears to be large enough to establish its reality. It will readily be seen that the difference in amplitude would be increased by using a velocity curve obtained by excluding the hydrogen lines as was done by Young in the case of the *H* and *K* lines of calcium.



A single case is insufficient to establish the theory, but it suggests a possible extension of the calcium envelope hypothesis to include the element hydrogen. The method employed is very simple in application when velocities by individual lines are published for spectroscopic binaries similar to the case selected.

DETROIT OBSERVATORY,
ANN ARBOR, MICH.,
Mar. 12, 1920.

AN AMATEUR'S OBSERVATORY

By F. S. Carrington

In June, 1918, I purchased a 4-inch astronomical telescope equatorially mounted on a tripod, with circles. I found it very unhandy to use this instrument set up in the open air, with the wind making it tremble more or less. I had been for several years using a field glass, but when snow and cold weather came during the winter months a great damper was placed on my desire for celestial observations out in the open. So I determined to build some kind of observatory so that I could enjoy the use of my more powerful, as well as much more costly, telescope. I had read in G. F. Chambers' "Hand Book of Astronomy" complete descriptions of building observatories for amateurs, with the cost, etc., in England. Thinking that it would be of interest to some of your readers, who like myself are amateurs, I am enclosing you a photograph with the following description of the observatory which I built in the fall of 1918. I selected a corner away from other buildings, where I have a clear horizon on three sides,—the north side is somewhat hampered with trees. In the centre of where the foundation was to be placed a hole was dug two feet deep and about the same square; this was filled with stone and concrete. A circular board frame was placed around this, three feet high. This frame was nine feet and four inches in diameter. Concrete and stone was built up inside of this to make a wall from six to eight inches thick. The space inside this wall was filled with loose stone to within six inches of the top. The centre was carried up from the ground with concrete and stone. All was now levelled off to the top of the board frame with concrete, making a smooth floor. As soon as this foundation was sufficiently cured, the frame, held together with wire hoops, was removed. On the top of this a circular wall six feet high was built of hollow vitrified or glazed silo tiles, and on top of this wall, which was carefully levelled, ordinary spikes projected from the masonry two and one-half inches, to hold the plate which was to form the track for the revolving roof. This plate was made like

a large circular wheel with felloes sawed out of two-inch yellow pine plank, on the top of which were solidly nailed similar felloes of one-inch fir, being careful to break the joints so as to hold the plate together, which was now three inches thick. Three-quarter inch strips were now sawed part way through so that they could be bent

MR. CARRINGTON'S OBSERVATORY

around and firmly nailed on the top of the plate, leaving a space between them two inches wide. Another plate was now constructed, exactly as the one just described, and to fit on the top of it. On the under side of this were screwed six two-inch truck casters at equal distances apart. These casters run around in the hollow space above described. On the upper side of the last plate straight rafters

of light material, about six feet long, are placed two feet apart, coming together in the centre; on these are nailed light ceiling boards and the whole covered with asphalt rubberoid roofing. There is an opening left between two rafters, over which a shutter opens and closes on hinges; by an arrangement of sash-cord and pulleys this shutter can be operated from the floor of the observatory. The telescope is mounted on a solid concrete column, reinforced and obelisk shaped. There are some hardwood pieces fixed in the concrete on top of this column, but capable of a circular motion so as to allow the proper and accurate adjustment of the telescope.

The total cost of the observatory to me did not exceed $75.00, all the work being done by myself with the assistance of a neighbour farmer (Mr. H. L. Felter, who reports the weather conditions here). The only part of the work paid for was the laying of the tile; this cost $8.00. By means of two double tent-pulleys and some sash-cord I can stand at the eye-piece of the telescope and revolve the roof with one hand in either direction. I have now used my observatory for more than a year, and for convenience, comfort and being always ready for observation, it is worth to me more than it cost.

I first set up my telescope on the forenoon of June 8th, 1918, intending to observe the solar eclipse in the afternoon, but so far as the telescope was concerned I was disappointed, for I broke the sun-glass first peep, and this although I had stopped the objective down to two inches. However, I was more than repaid later on. The seeing that evening and night was fine and I remained out until long after midnight, testing my new instrument and drinking in the grand sights. Saturn and Mars were in the western sky. About 11.00 o'clock I turned to the southeast, and there blazing in Aquila shone the Nova. I knew at a glance that it was a stranger but did not know exactly of what nature. I was certain the star had not been there many evenings, but there it was, fully as bright as Vega or Arcturus, brighter than Altair or Spica. When I turned the telescope upon it, it fairly burned and sparkled with a bluish light. I watched it for more than an hour. On Monday I wrote Mr. Hadden of Alta, and he wrote me that it was a new star that had first been seen on the evening of the 8th. Had it not been for my new telescope, I probably should not have been a discoverer.

WASHTA, IOWA.

THE FESTIVAL OF THE DEAD

By R. G. Haliburton,

(*Continued from page 111*)

It is not less interesting to mark the wreck of the southern year, and of its New Year's festival of first fruits and of the dead, over which the Vergiliæ once presided.

In some cases, as in ancient Egypt, in Britain and in Persia, we find it stranded in November as an ancient popular observance, though the year had long ceased to commence in that month. In other countries it drifted off from the autumn to form a New Year's festival in February. In one instance it shared the fate of the Pleiades, and took place, as the Lemuria of the Romans, in May, in which month it must have once been regulated by the heliacal rising of the Hesperides in the morning; while the year of two seasons only survived in fables as to the two-faced Janus, or as matters of doubt and mystery to astronomers.

So entirely have the history and "the pleasant influences of the Pleiades" been forgotten, that the latest work on the astronomy of the ancients does not even refer to the primitive year commencing in November, or to the Pleiades as dividing its seasons. Even where history has preserved the tale of the Aztecs regulating their cycle in November by the culmination of the Pleiades, Greswell considers the circumstance so remarkable as to deserve the special attention of astronomers, and assumes that, if explained, it will favor his view as to there having been once a miraculous suspension of the laws that govern the universe.

---

representation of him, given by Sir Wm. Jones, will leave but little doubt on this point. By his name, as well as by his crown of seven stars, he represents the Pleiades. By his faces looking in opposite directions, and by his six arms on each side, Janus bifrons, and the year of two seasons of six months each; while in the peacock, on which he rides, we have the well-known classical emblem of the many-eyed Argus, the watchful keeper of Io.

Sir William Jones calls Carticeya the Hindoo Orus; but Orus or Horus, Bunsen says, unites in himself all the myths of Isis and Osiris.

The persecutions of Io probably refer to traditions as to the seasons having changed, in consequence of a migration of races, and having become unsuited to the year and its festivals.

Icarus falling short in his flight, from Jupiter or the sun having melted the wax with which his wings were fastened on, must also have reference to a change in the time of harvest.

Now, it is a curious coincidence, if nothing more, that in Africa, to this day, *Oro* is still worshipped, as he is in Polynesia. *Isi* means a new period of time, *isimi* a feast or festival, and *ikore the harvest*.

See Sir Wm. Jones' Works, iii. p. 363.

Bunsen's Egypt's Place in Universal History, i. 434 to 437.

Dictionary of Yoruba Language, introd. xvii.

Bowen's Central Africa, p. 272, 317.

The learned have invariably ignored the fact that Greek mythology points with singular uniformity, not to Egypt or to Asia for its origin, but to Ethiopia and the ocean beyond Africa.

It is not gratifying, it is true, for civilized and refined nations to trace their origin to the savages of the Pacific islands, yet those persons who may dislike the conclusion to which this enquiry tends, may, if they agree in the correctness of my views, console themselves by remembering the monuments of an extinct civilization that are still to be found in those islands and that must have been the work of races far superior to the present natives of Polynesia.[57]

Yet the islands of the Southern Ocean most nearly realize the memory of the Fortunate Isles, "Where the air was wholesome and temperate, and the earth produced an immense number of fruits, without the labors of men." The early European voyagers, transported with the beauty and salubrity of the islands of the Pacific, fixed upon them as the primeval abodes of our race. Even nature would appear to confirm the impression. There the very ocean and the stars seemed subservient to man. The tides with unvarying regularity[58] mark morning and evening, mid-day and midnight; the Pleiades divide the seasons and regulate the year; and "the celestial clock,"[59] the brilliant southern cross, by its deflection in the heavens, proclaims the hours of the night.

The conclusions to which ethology[60] has led me, that we must look south of the equator if we would find the origin of our

[57] I refer here to the singular remains in the Easter Islands that have attracted so much attention.—Ellis' Pol. Res., iii. 325.

[58] "But the most remarkable circumstance is the uniformity of the time of high and low water. During the year, whatever be the age or situation of the moon, the water is lowest at six in the morning, and at the same hour in the evening, and highest at noon and midnight. This is so well established that the time of night is marked by the ebbing and flowing of the tide; and in all the islands the term for high water and midnight is the same."—Polynesian Res., i. 29.

[59] Humboldt's Cosmos, translated by O. C. Otté (N.Y., 1850), ii. 290.

[60] I may, I trust, be pardoned for coining a new word for researches into a subject hitherto considered to be either unworthy of attention or closed against regular investigation. That the customs and superstitions of nations are most wonderfully enduring memorials of the past, will, I trust, be apparent from some of the facts contained in this paper. When I come to treat more particularly of the festival of the dead and of its origin, this will be much more conclusively established. Even should the interpretations which I have given prove entirely incorrect, it will be plain that to more competent enquirers, the study of customs opens up a new and most interesting field, that is even more susceptible of scientific research, and that will shed more light on the social and religious life of primitive man, than philology itself.

The Father of History says: "Pindar appears to me to have truly said that custom is the king of all men"; and Sir William Jones, the only modern writer who seems to have duly recognized the value of these historical materials, suggests that if a comparison of the *times* of *observance* of the festivals of nations were made, "there would be found striking

November festival of the dead, or a solution for the traditions as to the Pleiades, receive a very significant confirmation from the following passage in a lecture delivered February 23rd, 1863,[61] by Professor Max Müller. His remarks, coming from one whose profound researches have shed so much light on the history of our race, are entitled to a peculiar weight. Referring to his attention having been recently drawn to the supposed similarity in the structure of Polynesian and Indo-European languages, he says, "strange as it may sound to hear the language of Homer and Ennius spoken of as an offshoot of the Sandwich Islands, mere ridicule would be a very inappropriate and very inefficient answer to such a theory." There are other theories not less startling than that, which would make the Polynesian language the primitive language of mankind.

Note.—In consequence of the above paper having exceeded the limits to which the writer wished to confine it, the following notes were omitted from the "Transactions of the Nova Scotian Institute." They have been inserted here, as they may help to explain or illustrate the subject.

In "Savonarola and his Times," (by Vasari of Pisa, 1863, 2 vols., translated by Leonard Horner, F.R.S., vol. II. 118), we read, "On November 2nd, *the anniversary of visiting the graves of lost relatives and friends* (giorni dei morti), Savonarola delivers another sermon, which had very great success, on 'what we have to do to secure a tranquil death.'"

The Florentine name, "the *days* of the dead," confirm my view as to this festival having been of three days' duration, or rather having lasted for two days, together with the preceding night or Halloween.

Greswell's very learned and elaborate works, to which I have referred, numbering eleven large volumes, could only be procured

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resemblance among them; and an attentive comparison of them all might throw great light on the religion, and perhaps on the history, of the primitive world." See Sir W. Jones' Works (ed. 1807), iv., p. 165.

I use the word *Ethology*, for although Ethics would really embrace these researches, that word has now acquired a limited and conventional meaning, while Ethology is quite as admissible as *Ethnology*, although Herodotus, I am aware, uses a different word from that which I have selected, when he refers to customs. Those desirous of knowing the views hitherto entertained as to the possibility of tracing popular customs and superstitions to their origin ,are referred to Brand's preface to his Popular Antiquities (ed. 1853), p. vii. to xi.

[61] Published in Macmillan's Magazine for March, 1863.

after this paper had been outlined, and only a few days before it went to press. The labor of analyzing so large a work on such an abstruse subject in so short a space of time, and particularly of applying my previous conclusions derived from a study of customs, as a substitute for the miracles, by which he tries to explain many remarkable features in ancient calendars, was necessarily very great. I have endeavored to supply all the necessary references to his works for the use of those who may wish to investigate the subject. The only points referred to by me, to which a comparison of customs and festivals had not previously turned my attention, were the noctidiurnal cycle, and the traditions as to the movements of the stars having been reversed.

That the system of counting the day from sunset is referable to the mode of regulating the year by the acronical rising of the Pleiades in November will be plain on examining the chapters he has devoted to this point. As to the belief of the Egyptians on the subject alluded to by me, I am unable to supply the reference, and have either overlooked it or my memory has misled me.

It is, however, immaterial, as the point is perfectly clear, that the institution of Halloween, and of the noctidiurnal cycle was, in Egypt, connected with the commencement of the Isia. The name for November was Athor, *i.e.*, the month of *the night*; and Apuleius, referring to the 17th day of that month, makes Isis say, diem, qui dies *ex ista nocte* nascetur, *aeterna mihi consecravit religio*.[62]

But the Pleiades, as we have seen, were called Athor-aye, *i.e.*, belonging to Athor, or the stars of All Halloween. It is interesting to note, that Volmer, though he is, apparently, not aware that Athor was, in some way, connected with New Year's day, and with the acronycal rising of the Pleiades, considers that it represented the *first night of Creation*,—a night, when time itself, commencing in the evening, gave rise to the noctidiurnal cycle.

Our Halloween is a vestige of a year that must have been disused in the north of Europe several thousand years ago. In place of the seasons of the Pleiades commencing in November and May, a year of two seasons regulated by the winter and summer solstices was substituted by the northern nations of Europe. But though it was a solar year and hence not necessarily commencing in the evening, it retained traces of the noctidiurnal system of the former year. Halloween was transferred to Christmas Eve, or Yule, and became "the *Mother Night*" (moedre[63] nech) of the year, while May day was shifted to the summer solstice, and began at St. John's *Eve*. There they still are, the memorials

[62] Metamorphos., xi. 257.
[63] Fasti Catholici, i. 199, ii. 107, 111.

at May and at November, of the year of the Pleiades; in December and in June of the solar year of two seasons; left behind like old moraines, and ancient sea margins, belonging to prehistoric. yet perfectly distinct eras, indestructible records of that unwritten history of man, which is preserved in the manners and customs of the people.

The soul cake of All Souls, the Halloween spirits, and the bon-fires of that night, reappear in the Yule dough, the Yule fire, and "the Juhlian company" or the ghosts of Yule, to whom the northern nations offered sacrifices on that ill-omened night.[64] To this day in the north of Europe the peasantry are afraid to go to Church on Christmas Day, because "they dread the apparition of spirits, which, they say, wander about the air in great numbers on that day, and which must be appeased by certain sacrifices."[65] These superstitions are not confined to Lapland, for in some portions of the Russian Empire it is still customary, on New Year's Day, to place food in the church-yards for the use of the spirits of the dead. Our Churches, ornamented with green boughs at Yule, the ancient New Year's day, remind us of the same preparations that must have been made, thousands of years ago, by our ancestors, to welcome the spirits to their New Year's festival of the dead; and recall to our mind Scheffer's description of the heathen inhabitants of Lapland, who, in his day, worshipped the dead among their deities, to whom they erected rude altars, upon which, Scheffer says, "they fix round about branches of birch and pine, as they do strew the ground about with the boughs of birch." "During the summer season, they take great care to adorn the place all round about with green boughs of trees; *in the winter with branches cut in small pieces,* which as often as they dry up, other fresh ones are laid in their stead."[66]

But the change from May day was even more marked. St. John's eve[67] almost extinguished the bon-fires of the eve of May day, and both still share in many singular features. We have the May queen[68] reappearing on St. John's eve, and the May pole again set up. The British peasantry once supposed that[69] "all the spirits, ghosts and hobgoblins were abroad on that night." In Cornwall, at old Tumuli (the graves of ancient British chieftains of forgotten fame), on which a pole is erected, and in which the

[64] Scheffer's Lapland, 102.
[65] Scheffer, 87.
[66] Scheffer's Lapland, pp. 76, 77. See as to our Christmas customs, Brand, i. 520 to 525.
[67] Wylde's Superstitions of Irish Peasantry, p. 38.
[68] Brand, i. 364, 317.
[69] Id. 305, also articles on May Day, St. John's Eve, Hallowe'en, and Christmas.

rustics believe that "giants are buried," whose bones "nothing would tempt them to be so sacriligious as to disturb," we find the peasantry kindling fires and dancing on midsummer eve, in the same manner that the Fijians, at their festival of the dead, dance around the bon-fires, which they light at their only temples, the burial mounds of their last Tooitongas.

The spirits of the dead, which among almost all savage races, are supposed to reappear in the form of snakes (hence the Greek python *Ob*, the serpent, *i.e.*, the dead), are at large as "flying dragons in the ayre." In Cornwall it is the opinion of the vulgar, that "it is usual for *snakes to meet in companies*" on Midsummer Eve; when, by joining their heads together, by their hissing they form bubbles which harden into the magic "snake stone," the sacred amulet of northern nations. But, in spite of the change of the seasons of the Pleiades to the two seasons of the solstices, there are not only distinct vestiges of the more ancient year in Halloween and May day, but even in the traditions of the north. "Diodorus," Greswell says, "mentions an Hyperborean tradition, which would imply that the primitive tradition of the north, with respect to the *natale mundi*, and the origin of time itself, agreed with that of the rest of the world, and placed it *where the universal belief of mankind concurred in placing it: that is, in the beginning of spring.*"[70] The only portion of the globe where a primitive year commencing in the spring is to be found is south of the equator, where we have a year commencing at Halloween, and regulated by the Vergilæ, the stars of spring.

What could have been that year commencing in the spring, once in vogue among northern nations? It is plain that it was the primitive southern year commencing at Halloween. Our November festival of the dead, and our May day are in Britain, as in Peru, the vestiges of that privemal year, a year obsolete perhaps in the days of Odin, but long lingering probably in northern Europe, as it did in Peru, among the common people, in spite of the introduction of a solar year. It can hardly be imagined that among northern nations the beginning of the primitive southern year was transferred to the commencement of the second season in May. The festival of agriculture and of the dead still preserved in November, as well as the very name All Halloween, precludes such a supposition. But the year that was substituted removes all doubt upon the point. Why did the solstitial year commence (like our present year) at such an unseasonable time as midwinter? Simply because, in substituting the solstices for the acronycal rising of the Pleiades, all Halloween was transferred to Yule, or the winter solstice. Had the primitive year

[70] Fast. Cath., ii. 109

begun in May, "the Mother Night" would have been Midsummer eve, and would not have been shifted back to Christmas. Hence it is plain, that the tradition of a year commencing in the spring points to the primitive southern year beginning at Halloween, and leads us to southern latitudes,[71] where the year still commences in November, and begins with a Halloween, when the Vergiliæ or Hesperides, rising in the evening, are "worshipped as a constellation that announces spring."

Can we be surprised at finding that the memory of this migration of races to the far north, and of the primitive southern year having been carried with them through all the changes of seasons and of climate, should be preserved in strange myths as to the wanderings of the Pleiades; or that the tradition should long survive, that the seven stars were for years compelled to fly from the pursuit of Orion,[72] and that their movements in the heavens had been reversed?

ἑπταπόρου τε δρόμημα Πελειάδος
εἰς ὁδὸν ἄλλαν Ζεὺς μεταβάλλει[73]

Nor can we wonder that the Hesperides rising on the primeval Halloween, and thus making "the evening and the morning of the first day" of the year, should have left such distinct evidences of their influence throughout the world, as to excite the interest and attention of astronomers, who have been surprised at the universality of the noctidiurnal cycle, though ignorant of its origin.

"The matter of fact then," says Greswell, "which inquiry into the rule of reckoning the cycle of day and night, in all quarters of the world, and at all periods of human history, brings to light, being everywhere the same: the conclusions deducible from it rests on the broad basis of an almost universal induction, viz., that there must have been, from the first, a simple and uniform rule of this kind, everywhere observed; a rule cœval with the origin of time itself, and as widely extended as the compass of the habitable globe; a rule from which every other (even those that superseded it) is to be derived; but in comparison of which, in point of antiquity and in point of extent, even those that have been longest substituted for it, and most generally used instead of it, are of recent date and of limited circulation, none having been original, and independent of everything else of the same kind; none having existed from the first, and none having been universal but this."[74]

[71] Greswell's Fasti Catholici, ii. 104, 111.
[72] Fast. Cath., iv. p. 180.
[73] Eurip. Orest., 1001.
[74] Fasti Cath., i. 219.

ADDENDA

The necessity of compressing the subject into such narrow limits, has rendered the following additional remarks unavoidable, in justice to a branch of enquiry, of which I feel I have given a most imperfect outline.

Since the publication of the foregoing paper on the Festival of the Dead, Mr. William Gossip, the Secretary of the Nova Scotian Institute, has drawn my attention to the Rev. William Chalmers' remarks as to the existence of the year of the Pleiades among the Dayaks of Borneo. The facts mentioned by him, in addition to others which I have recently discovered respecting the Fiji and the Sandwich Islands, almost settle the point, that the identity in the November festival of the south with that of northern nations, cannot possibly be accidental; and confirm my conjecture as to the probability of the year of the Pleiades, and the new year's festival of first fruits and of the dead, being found to exist throughout the islands of the Pacific, and of the Indian Archipelago.[1]

We have seen that, north of the equator, in Hindostan, Persia, and Egypt, November was connected by its very name, either with the Pleiades, or with the festival of first fruits and of the dead. The Bœotians designated it the month of Ceres. Even many of the northern nations of Europe, though they appear to have, thousands of years ago, transferred "the mother night," and the beginning of the year, from Halloween to Yule, retained traces of the ancient year, not only in the festivals of All Halloween, All Saints, and All Souls, but also in the very name of November, which was called among the Anglo-Saxons, the Dutch, the Danes, and the Swedes, the *month of blood* or of *sacrifice*.[2]

[1] See ante, note to p. 31.

[2] See le Monde Primitif, iv. 89 to 114.

Gebelin, whose learned work on the Calendars of the Ancients I have only been able to consult since the publication of the foregoing paper, will be found to confirm my views (see ante, p. 23; also see notes p. 25 and 26) in very many particulars, especially as regards the 17th day of the month, which, he says, was regarded by the Egyptians, Hebrews, Greeks and Romans as an unlucky day. Almost every page of his profound Histoire Allegorique du Calendrier will be found to throw some light on many of the subjects touched upon in this paper.

I am inclined to think, from further investigation, that though the festival of the dead, among very many races, took place in "the dark nights of the moon," it was frequently held also at the time of the full moon, like

South of the equator we have seen that the month of November is also connected either with the Pleiades or with the new year's festival of agriculture and of the dead. In Peru it was called "the month of carrying corpses." In Australia, in November takes place the festival of the Pleiades: at which time is held, in the Tonga or Friendly Islands, the feast of Alo Alo, the God of Agriculture, who is wedded to the little damsel, the November Queen of the Spring.

The Fiji Islands, though peopled by a Melanesian race, almost form part of the Friendly Islands, and the manners and customs of the inhabitants of the two groups are strikingly similar, and in many respects resemble those of the natives of Australia, from which those islands are not far distant.

Among the Fijians, the Australians, and the Friendly Islanders, we find, connected with November, the rude outlines and elements of almost all the myths and traditions associated by northern nations with that month, most of which have hitherto never been satisfactorily explained.

No solution has yet been found for that strange myth of the Egyptians, almost the basis of their religion, viz., that in November Osiris, the God of Agriculture and "the Lord of Tombs" comes from the world of spirits, and is restored to his sorrowing spouse. Nor has any explanation been given for the Autumn festival among the Greeks, in which the rape of Proserpine, or the marriage of that Goddess "in autumn wed" to the God of Hell,

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the monthly corroborees of the Australians. (It is worthy of notice that the festivals are called, among natives of Madagascar, *Kabbarees*.) In such cases, if the month began at the time of the new moon, the 17th, 18th and 19th nights of the month would be the three nights succeeding the full moon. Mr. Chalmers says of the Dayaks, "During the farming season, the day after the full moon, and the third day after it are 'Pamali'; and no farm work can be done" (Colonial Church Chronicle, 1861, p. 254). The Chinese and Hindoos seem to have combined both systems, the former holding the festival of the dead at both the time of the new and of the full moon, and the latter regulating their months by two systems, viz., by the full and also by the new moon. It is plain that, from the existence of these two systems ,a confusion, not only as to the beginning of the month, but also as to the day on which the year began, must have arisen.

The facts, however, are perfectly consistent with my reasoning as to the Egyptian and Attic year commencing on the 17th day of the 1st month; and also will explain why, among many races, the primitive Southern year, and the annual festival of the dead began, not on the 17th, but on the 1st day of November. I believe the conclusion will be found in almost every instance to be correct, that the primitive Southern year began with the monthly festival of the dead, near the time of the culmination of the Pleiades at midnight, i.e., of their acronycal rising in the evening.—See Illustrated London News, Oct. 3, 1863. Monde Primitif, iv., 120, 193, 254, 291 et passim.

was celebrated at the time of the acronycal rising of the Pleiades. No clue has been supplied to the belief of the ancient Persians, that winter comes up from hell at the beginning of November, "the month of Death" (Mordâd), which is also known among the Arabs as Rajeb ("the Month of Fear").[3]

The festival of Kali the goddess of death, and the spouse of Siva, "the destroyer," takes place in Hindostan in November (the month of the Pleiades). Both of them, like Osiris, "the Lord of Tombs," are honoured as "delighters in cemeteries," the goddess, like the wife of Alo Alo, being represented by a little girl. The explanation of these myths will be found in the new year's festival of first fruits and of the dead, among the races of the far South.

The Fijians, like the ancient Greeks and the Egyptians, believe that *in November a god comes up from the infernal regions.* He is named Ratumainbulu, and is, like Osiris, Kali, and Proserpine, a deity presiding over agriculture—and "a god of great importance in Fiji, as he causes the fruit trees to blossom, and on him depends the fruitfulness, or otherwise, of the seasons. There is a month in the year, about November, called Vula i Ratumainbulu (the month of Ratumainbulu). *In this month the god comes from Bulu, the world of spirits,* to make the bread-fruit and other fruit-trees blossom and yield fruit. He seems to be a god of peace, and cannot endure any noise or disturbance, and his feelings in this respect are most scrupulously regarded by the natives. They, therefore, live very quietly during this month, it *being tapu to go to war or to sail about, or plant, or build houses, or do most kinds of work,* lest Ratumainbulu should be offended, and depart again to Bulu, leaving his important work unfinished."[4]

As the Fiji Islands are adjacent to the Friendly or Tonga Islands, and the natives of both groups strongly resemble each other in their customs and observances, there can be but little doubt that Alo Alo, the God of Agriculture of the Friendly Islands, whose festival takes place in November,[5] is the same as the Fiji god, and like him is assumed to come in that month from the world of spirits, which is called by the Fijians *Bulu,* and in the Friendly Islands *Bulotu.* For the same reasons we may assume that a vernal queen, like the little damsel who presides at the festival of Alo Alo, also welcomes the Fiji god, on his arriving in that month from the land of spirits—as Isis welcomed Osiris, and Proserpine wedded Pluto in November.[6]

[3] Fasti Catholici, ii. 99.

[4] See Erskine's Islands of the Western Pacific, p. 244.

[5] See ante, p. 28.

[6] If the Greek and Sicilian festival in honor of Proserpine was regulated by the acronycal rising of the Pleiades, the month in which it occurred, must have, 2000 years ago, more nearly corresponded with October

But the customs of the Fiji savages throw an entirely new light on one of the most obscure points connected with ancient mythology, and on one of the most puzzling features of the Egyptian and Grecian mysteries. Isis is represented as going, on the 19th day of November, at midnight, *i. e.* on the third day of the Isia, or of the new year's festival of agriculture and of the dead, to the Banks of the Nile, where she places Osiris in the ark or coffer, which is carefully washed with water. In the Eleusinian mysteries, the ark or mystic boat was a well known feature.

Ingenious, but most far-fetched conclusions have been arrived at by the learned, respecting the meaning of this rite. It is to be found in the festival of the Fiji God. Erskine says, respecting him, that "the priests announce the time of his coming from the other world, and also the time of his departure, when it again becomes lawful to pursue their usual labours. But before he leaves the world the priests have to bathe him, lest he should have contracted any impurities during his residence and occupation in the world. This custom probably arises from one of their own—that of always going to bathe after they have done their work. Be this as it may, *the priests bathe the god, and send him away to Bulu,* immediately after which *they raise a great shout,* which is carried from town to town."

This Fiji festival gives us a clue to the ceremonies in honor of Durga, or Kali, the goddess of nature and of the dead, celebrated about the beginning of October. In Hindostan, we find from the 1st of October to November, the scattered fragments of the primitive new year's festival. The lanthorn festival is held in November; the feast of ancestors, of which it once formed a part, occurs early in October, while two, if not more festivals are held in honor of a Deity that combines the attributes of Isis, Ceres and Proserpine, and is, like them, the mythical embodiment of the new year's festival of first fruits, and of the dead. "Her *fast* falls on the last day of the moon of September, and she is worshipped *all the night of that day universally.*" "On this fast also worship and offerings are paid to the manes of deceased ancestors."[1] Dubois speaks of a festival "called by the Hindoos Mahanavami, which is destined principally to the honor of deceased ancestors. It is celebrated in the month of October, *during a period of three days*; and is so religiously kept, that it has become a proverbial

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than November. The same remarks will apply to the festival of Kali in Cartica (the month of the Pleiades). See Sir William Jones' Works, iv 135; see ante, p. 14, 16.

[1] Maurice's Indian Antiquities, ii. 184.

saying, that those who have not the means of celebrating it, should sell one of their children to procure them."[8]

At this festival the goddess Durga, the same as Kali, the goddess of nature, is worshipped. In every house there are earthenware images, into possession of which the Brahmins ceremoniously induct the goddess. There are great feasts and rejoicings, while she is a visitor. On the third day a most imposing ceremony takes place, viz: that of sending the goddess back to heaven, which is done by means of water. "In each family," says Mr. Wright, in describing this festival, "the officiating Brahmin engages, with various rites, sprinklings, and incantations, *to send the goddess back to her native heaven*; concluding with a farewell address, in which he tells the goddess, that he expects her to receive all his services, and to return again to renew her favors in the following year."

Almost the whole population of Calcutta, at the close of her festival, flocks to the banks of the Ganges, which is covered with innumerable boats. At a given sign all the images are broken and cast into the river. The same writer, who was once an eye witness, thus speaks of the scene presented by the innumerable crowds that are then assembled—"Who can depict the wondrous spectacle?—the numbers without number; the fantastic equipages of every rank and grade; the variegated costumes of every caste and sect; the wild and phrenzied excitement of myriads of spectators intoxicated with the scene; the breaking, crashing, and sinking of hundreds of dispossessed images, along the margin and over the surface of the mighty stream,—amid the loud and shrill dissonance of a thousand untuneful instruments, commingled with the still more stunning peals of ten thousand thousand human voices."[9]

This account of the Hindoo festival recalls to our minds the vast crowds on the Nile at the festivals of Isis described by Herodotus, and the shout that was carried far and wide throughout Egypt, announcing that Osiris was found.

What could have been the origin of sending the god of the dead back to the land of spirits, by immersing his image in water? We must turn to the simple basis of all these observances, to the funeral ceremonies and annual commemorations of the dead, to

[8] Dubois' Manners and Customs of the Hindoos, p. 384. See Sir William Jones' Works, iv., 132, as to the festival of the dead, which clearly forms part of the festival of Durga or Kali, "the *three great days* of that festival."

[9] India and its Inhabitants, by C. Wright, M.A., sixth edition. Boston, Mass., p. 221. See also Montgomery's Voyages and Travels Round the World, p. 242; also see as to year of the Pleiades and first fruits offerings in Polynesia, etc., 76, 77, 78; as to Chinese festival of the dead, 209.

solve the meaning of those mythical beings and rites, that sprang from the new year's festival of agriculture and of death.

At Hindoo funerals three stones are placed on a small pile of earth, representing the deceased and the deities presiding over the dead. On the tenth day the officiating Brahmin "carries them to a river or tank, and going with them into the water up to his neck, he turns to the sun, which he addresses with these words, 'up to this day these stones have represented the deceased. Henceforth let him cease to be a corpse. *Now let him be received into Paradise.* There let him enjoy all blessings as long as the Ganges shall continue to flow.' In pronouncing these words, he casts behind him the stones and the vessels he holds in his hand, and returns to the banks of the pond." [10]

Thus the rites observed in honor of Durga, are the same paid to the dead by the Hindoos; but her festival, we have seen, was connected with and evidently grew out of the primitive festival of the dead.

A similar mode of sending the spirits of the dead to Paradise by water, is resorted to in Japan, at the Feast of the Lanthorns, or the festival of the dead. The festival lasts three days, or two days including a Halloween. On the first evening they light up the grave-yards to guide the spirits to their former homes; on the second day feasts and rejoicings are held in every family in honor of their unseen guests; and at midnight they launch forth into the sea a boat made of straw, which they light with tapers, that the souls may be cheered on their dark journey to the world of spirits.

At the festival of Isis, the Egyptian priests, proceeding to the sea shore, placed the image of Osiris into the sacred coffer or boat, and launching it out into the sea, watched it as it was borne out of sight by the winds and waves.[11]

All these mystic rites of the Hindoos and the Egyptians resolve themselves most clearly into customs still practised at the festival of the dead.

Isis and Osiris are manifestly the same as Kali or Durga, and her husband Siva. Apuleius makes Isis say, "I am nature"—"the Queen of the Dead"—"the greatest of the Gods." The Puranas thus address Kali—"Oh dweller in cemeteries, bearer of a skull, borne on a car drawn by ghosts,"—"bearing the moon on thy matted locks, and on thy neck a string of skulls." [12] She is worshipped as the Goddess of Nature, and supreme over all the gods.

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[10] Dubois, p. 297.

[11] St. Croix, Les Mystères du Paganisme, ii. 162.

[12] See the Lainga Puran, part ii. ch. 100; also Padma Puran, v. ch. 5 Garura Puran. See also "India and its Inhabitants," 261.

[48] *To be Continued.*

BOOK REVIEWS

Studies of the Nebulae. Made at Mount Hamilton, California and Santiago, Chile. 268 pages of text and 50 plates, being Volume XIII of the Publications of the Lick Observatory and issued from the University of California Press, 1918.

This extensive treatise, just to hand, is divided into six parts, three of which are by Curtis, one by Campbell and Moore, one by Wilson and one by Wright. Considerable of the matter has beeu published in various journals during the past few years but it is here given in detail in a splendid volume and forms an outstanding contribution to our knowledge of the nebulae.

Part I. *A Description of 762 Clusters and Nebulae*, by *H. D. Curtis.* All nebulae and clusters made with the Crossley Reflector from 1898 to February 1st, 1918, are here described. Of the 762 entries there are 513 spirals, 56 diffuse nebulosities, 36 globular clusters, 24 sparse clusters, 78 planetary nebulae, 8 "dark" nebulae and 47 unclassified. Photographs are shown illustrating each type. In his early work on the nebulae Keeler had estimated that there were approximately 120,000 small nebulae in the heavens. Perrine, on completing the original Keeler programme, was of the opinion that 500,000 or possibly double that number were within reach of the Crossley reflector. Fath, on the other hand, was led to assign a much smaller number but Curtis believes that the coarse-grained plates used by him militated against discovery and concludes by stating that at least 700,000, and very probably 1,000,000 small spirals are within reach of large reflecting telescopes

Part II. *Occulting Matter in the Spiral Nebulae*, by *H. D. Curtis.* It has long been known that certain spirals seen egdewise show a dark lane running down the length of the spiral, an appearance

generally explained as due to a band of absorbing or occulting matter. With the purpose in view of showing that such a phenomenon is a relatively common one he examines the photographs of the 500 odd spirals secured with the Crossley, and reproductions of 77 of these are given, arranged in compact form with their long axes horizontal, so that at a glance the pictorial evidence of such absorbing matter is quite pronounced. An examination of those spirals whose planes are nearly perpendicular to the line of sight reveals irregularities of structure with one whorl of the spiral longer or brighter than the others. This irregularity of form or difference of intensity should, when we consider a large number of cases, give asymmetrical effects with regard to the major axes in the elongated forms and as such is not found to be the case other causes than mere irregularity of distribution are suspected. And while in those nebulae like *M 81* and the *Andromeda*, which make a considerable angle with the line of sight, the lanes seen more prominent on one side of the major axis than on the other might be ascribed to actual vacancies between the nebular whorls he prefers to ascribe them to occulting matter.

There are manifestations in our own galactic system of occulting material, and while it may not be safe to assume similar conditions to hold in the spirals, yet a review of such evidence seemed in order. Photographs and star counts show a falling off in the number of the stars in the vicinity of the diffuse nebulosities and rifts and dark spots are encountered within the nebulosity itself. The famous "coal sacks" and Barnard's photography and description of many such "dark" nebulae make it appear that occulting matter is quite common. The author further touches upon the question of stationary calcium clouds in space as being the interpretation of the sharp *H* and *K* lines of constant velocity so frequently found in stars. He gives a list of 24 such from a catalogue of spectroscopic binaries in press; more might be added, but the contention that stationary clouds are the cause of the phenomena is debatable, though most of the stars do seem to be connected with nebulosity. In any case the evidence is fairly strong that dark clouds of matter are a feature of our stellar universe and may with reason be presumed to feature other universes.

Part III. *The Planetary Nebulae*, by *H. D. Curtis.* A series of photographs of the 78 planetary nebulae north of 34° south declination was undertaken in the belief that a collection of illustrations showing the forms assumed would contribute to theories of the structure and life history of these bodies. As some of these do not exceed 30 seconds of arc in diameter a ten-fold enlargement of the original negatives would give an image of them on the printed page of only three-tenths of an inch. Further, the great differences in brightness between the central portions and the outlying parts made it impossible for a single photograph to do justice to any one object. To overcome these drawbacks in depicting structural details the author adopted crayon drawings as the most satisfactory procedure; the composite drawing being based upon several plates of the object having varying exposure times. In several of the larger ones he gives the direct enlargement as well, and these serve to indicate how faithfully the details in the original negatives seem to have been reproduced in the drawings.

By recording the exposure times necessary to make the object comparable to the brightest part of the Orion nebula he leaves the future investigator with an idea of the brightness of each. Diagrams indicate the concentration of the planetaries in the galactic plane; particularly is this true of the smaller (apparent) ones which are considered to be at great distances. In an attempt to learn the actual form of the planetary he is led to the conclusion that a spherical or ellipsoidal shell is inadequate to explain the numerous ring forms where the matter inside the ring is but a small fraction of the brightness of the ring itself, and the question is left somewhat open. Even though associated with a central star, planetaries do not fit in with any scheme of stellar evolution and may be regarded as exceptional or sporadic cases.

Part IV. *The Spectrographic Velocities of the Bright-Line Nebulae*, by *W. W. Campbell and J. H. Moore.* From the time of Keeler's visual determination of the velocities of the Orion and 13 planetary nebulae in 1890, in which he found the former to be practically stationary with reference to the stellar system and the latter to have velocities unusually high, some even as high as 65 km. per sec., nothing much was done in this line until 1913 when the present investigation was started. Many combinations of

prisms and cameras were used, the one deemed most suitable for the case in hand being employed. A three-prism short focus arrangement proved very effective. In the most favourable cases, where the bright lines were not vitiated by rotational or other effects, an accuracy equal to that of stellar radial velocities was secured even though the exposures were of 10 or 20 hours duration.

The velocities of 125 nebulae were obtained, and while the well-known preference of these bright-line nebulae for the Milky Way militates against using their velocities to solve for the apex of the sun's way, yet after discarding those in the Magellanic Cloud and others equally abnormal and using the apex R.A. 270°, Decl. +30°, 101 objects give a velocity for the solar system of 28.3 km. per sec.; a velocity which may be considered representative of those distant parts of the stellar system in which the observed nebulae lie. The average radial velocity of the 96 planetaries is about 30 km. per sec. and thus they can hardly be the forerunners of the *B*-type stars whose velocity is about 6 km. per sec.

Quite early in the work it was decided to test for rotational effects in those planetaries of elliptical form, as these might reasonably be considered as rotating about their short diameters. By setting the slit along the long diameter of N.G.C. 7009 the inclination of the spectral lines showed clearly that one edge was receding and the other approaching, though the outer portions seemed to lag somewhat behind. Evidence of rotation was thus secured in a score of such planetaries. Confirmation was also obtained of the variations previously found within the great nebula of Orion, the range of variation amounting to 13.5 km. per sec. within one minute of arc from a point in the trapezium, but their results did not favour the hypothesis of rotation of the nebula as a whole.

Upon certain assumptions as to the distances of these rotating planetaries the authors are enabled to arrive at an approximation to their masses which seem to be much greater than that of our solar system.

Part V. *The Radial Velocity of the Greater Magellanic Cloud*, by *R. E. Wilson*. The mean of the velocities for 17 nebulae within the Greater Cloud, the interagreement of which is good, is found to be+276 km. per sec. One nebula in the Lesser Cloud gives a velocity of +168 km. per sec.

Part VI. *The Wave-Lengths of the Nebular Lines and General Observations*, by *W. H. Wright.* Preliminary determinations of the brighter nebular lines were made by the author in 1901 and the first part of the work deals with securing added accuracy in these values. An extensive table of the wave-lengths found in the fifty nebulae observed, with their relative intensities and the mean values accepted, with probable origins, sums up this phase of the work. In 1914 the discovery was made that the nucleus of the nebula N.G.C. 6572 gave the emission band λ4686 thereby establishing a relationship between it and the Wolf-Rayet or *O*-type stars. The second phase of the work then deals with the examination in this regard of many nebular nuclei. In carrying out this work it was found that certain radiations emanated from all portions clear across the nebula whereas others were localized in the nucleus, and this investigation of the distribution of these radiations throughout the nebulae constituted the third division of his subject. About 45 illustrations of nebular spectra are shown some taken with the slit spectrograph and others with the slitless spectrograph, which latter show the form of the nebula according to the particular wave-length concerned.

Some general observations are dealt with in his closing chapter. A provisional classification of nebulae is suggested depending upon the extent of the λ4686 radiation. He notes that the spectrum of the Orion nebula is practically identical with a certain class of planetary nebulae and it thus appears probable that its physical state is not sensibly different from theirs.

When one reads that in connection with the radial velocity of one object alone (the Orion nebula) the total exposure time was nearly 400 hours he must be impressed with the enormous amount of work represented by the publication. The volume is, as previously stated, an outstanding one and worthy of the great observatory which issued it.

W. E. HARPER

Petit Atlas Céleste, par G. Bigourdan, Membre de l'Institut et du Bureau des Longitudes. 56 pages and 5 maps in colour; paper; price 2 francs; 2me ed., 1920.

Tables Logarithmiques et Trigonometriques, par H. Rocques Desvallées, Calculateur principal au Bureau des Longitudes. XXIV+72 pages, paper, 4 francs, 1919.

Problemes Astronomiques, par Lieut.-Col Delauney. 52 pages, paper, 1920. All published by Gauthier-Villars, Paris.

The small star atlas by Bigourdan contains a concise but scholarly account of the origin of the constellations, their number, those now discarded, those now recognized. Then follow instructions for recognizing them by their position and a table giving the R.A. and Decl. of their chief stars. The five maps cover the entire sky, one comprising the north-polar stars, another the south-polar stars, and the remaining three the equatorial stars.

The pages are of such a size that by trimming the wide margins a little the book will slip easily into the pocket and be a useful companion to the amateur observer. If I should offer any criticism it would be that the type is rather small. I also noticed that on map II Rigel is marked as a 3rd magnitude star.

The tables by Desvallées are chiefly to four places through the logs. of the natural numbers and of the circular functions are also given to three places. They are intended for the use of the engineer, the physicist, the navigator and for some of the work of the astronomer.

Besides those ordinarily found there are tables for angles expressed in time and also in decimals of a degree, and also for addition, subtraction and reciprocals.

The tables are exceptionally well arranged for rapidity of use and the instructions, including solved examples, show that the work is produced by a competent computer.

The little work by Delauney is a study in statistics, and deals with six problems: the distances of the satellites, the Milky Way, sun-spots, meteor swarms, the system of the earth, and the troubles of humanity. The writer concludes that each family of satellites can be divided into two classes, the distances of the members of one class being in arithmetical progression, and those of the other in geometrical progression. His examples are not very convincing.

There are many gaps in the series, and the numbers are very roughly approximate. In the case of Uranus he attributes eight satellites—two discovered by Lassell, and six at one time thought to have been seen by Herschel. The system of the Pleiades is invoked as illustrating the law of distances, but surely the conditions here are very different from those in the satellites of a planet.

Next, an attempt is made to deduce somewhat similar laws of the distances of the stars in the Milky Way, but the smal number of parallaxes determined and the'r probable errors, render the effort of no value.

From a certain symmetry in the dates of the maxima of the sun-spots which the writer thinks he has discovered he deduces a theory that the sun-spots are due to the passage of the sun through a nebula composed of a nucleus and a series of equidistant rings.

By a comparison of the dates of meteor swarms and the recorded temperatures at Paris he concludes that the temperature is higher at the time of a swarm than when it is absent.

He also thinks that our meteorological phenomena are periodic and should be attributed to terrestrial satellites which are none other than chains of meteors.

Lastly he brings forth evidence to show that wars and revolutions and other human troubles have some correspondence with cosmic phenomena such as earthquakes. He thinks this is borne out by the dates of the French Revolution, the Franco-Prussian war and other upheavals, all those quoted being ones in which France is chiefly interested. He might have referred to the great American Civil war and the ever-present Irish trouble. But here as in the other cases the evidence is far from convincing, being indeed, in some instances, almost fantastic and fragmentary.

All through the book the statistics are incomplete and unable to bear the conclusions drawn from them.

C. A. CHANT.

MEETINGS OF THE SOCIETY

At Toronto

March 30, 1920—The Society met in the Physics building of the University, at 8 p.m.. Messrs. George Hartman, Turbine, Ont.; W. P. Taylor, Calgary, Alta.; and Capt. S. B. Lindsay, Montreal, P.Q., were elected members of the Society.

The aurora of March 22nd, was discussed at some length. Mr. A. F. Hunter, described its appearance, and the position of the focus, and Prof. Chant, explained the relation of the focus to the magnetic zenith. Mr. A. F. Miller, spoke of the wonderful group of sun spots which appeared on the sun's eastern limb, on March 15th, and which had just crossed the sun's meridian, the day previous to the display. The group extended to a distance of at least 250,000 miles. The leading spot showed tremendous activity, bridges being thrown across the umbra, from time to time. The group disappeared over the western limb on the 27th. The president drew attention to the fact that the major part of the display was in the south, an unusual occurrence in our latitude.

The paper of the evening was given by Prof. H. A. McTaggart, of the Staff in Physics, his subject being—"Light, a wave phenomenon". The lecturer briefly traced the development of the theory from the time of Newton, showing the pictures of those physicists who contributed to the science. Several experiments demonstrated the production and propagation of sound and water waves, the difference between these waves and light waves being explained. Interference was nicely shown by soap bubbles and Newton's rings. Polarization of light was demonstrated. Reference was made to the starch grain process of colour photography, and two slides beautifully illustrated what can be accomplished by this method. The scientists of to-day are devoting their attention almost exclusively to the study of the atom and the electron, whose motions in the ether give rise, not only to light waves, but also to those vibrations known as X-rays, ultra-violet rays, electrical and wireless waves.

Mr. Miller announced that Sir Charles A. Parsons, in "Nature" of February 26th, last, in an article on "Researches at high Temperatures and Pressures" stated, that, "the transformation of only a minute fraction of the mass of two stars in collision would be amply sufficient to absorb the whole energy of the collision". This bears out Mr. Miller's theory which he advanced in his address to the Society on January 27th last, whereat he stated that "the radiation and

expansion of a Nova would not alone account for the decline in brightness, especially during its earlier stages. The process of disintegration of elementary materials and the formation of Nebulium, in enormous quantities would supplement the above reasons and satisfactorily explain the diminution of light and heat".

April 6—The Society met in the Physics building of the University, at 8 p.m., the President, Mr. J. R. Collins, in the chair.

The following were elected members of the Society: Rev. R. L. Fleming and Mr. W. S. Vaughan, Toronto; and Mr. H. S. Patterson, Calgary, Alberta.

The monthly report of the Librarian showed that 18 books were added, and 47 publications received during the previous month.

The paper for the evening was given by Prof. G. R. Anderson, of the University of Toronto, on "Stereoscopic Photography, and some of its Applications". The image formed on the retina when an object is viewed with only one eye is simply a drawing. When, as is usually the case, an object is viewed with two eyes, the image formed on the retina of the one, is slightly different from the image formed on the retina of the other eye. These images are combined to produce a mean image which is the one presented to the brain. It is thus the change of position, or what is technically known as parallax, which produces the stereoscopic effect.

Wheatstone, in 1833, perceived the basis of perception in three dimensions and made a stereoscope. Later, Brewster, in 1843, devised the stereoscope used today. This principle has been applied to binoculars, microscopes and rangefinders, which instruments the lecturer explained in some detail.

Previous to the development of photography, drawings were viewed stereoscopically. The subject became very popular when it became easy to make stereoscopic pictures. An ordinary camera may be used, the same view being taken at the ends of a convenient base line. The length of the base line varies considerably, from a few inches for near objects to several yards for mountain views and lake scenes. For stellar photography the pictures are sometimes taken on successive days, thus employing a base line of one nad a half million miles.

Using two lanterns, the lecturer projected many pictures of his own manufacture on the screen. These exhibited the stereoscopic effect very beautifully, the most striking examples being pictures of a comet and a view of Saturn. The singular manner is which these bodies appeared to stand out from the background of the stars was indeed very wonderful.

J. A. PEARCE, *Recorder*.

NOTES FROM THE METEOROLOGICAL SERVICE

Summary Report of the Weather in Canada
February, 1920

Temperature

The temperature was from 1° to 4° below the average in the Peninsula of Ontario, northward to the Straits of Mackinaw, and eastward to near the Boundary of the Province. It was average over the Southern portion of British Columbia, and elsewhere in the Dominion above the average. In the Western Provinces the positive departure was very marked, varying from 5° in Manitoba to as much as 13° in portions of Saskatchewan and Alberta.

Precipitation

The precipitation in British Columbia was unusually light, being from 3 to 6 inches below the average on Vancouver Island and over the Lower Mainland respectively, and from 0.75 of an inch to 1.50 inches below in the Interior. In the Western Provinces it was below the average, except at one or two points, where there was a slight excess. The deficiency in many localities being equivalent to half of the normal amount. In Ontario also it was much below, except at a few scattered places, where the average was just exceeded. In Quebec in the extreme western portion there was less than usual, with a small excess over the large remainder of the Province. In the Maritime Provinces it was everywhere exceeded, and except in Cape Breton, to a large amount. St. John registered a positive departure of 4.60 inches; Yarmouth and Charlottetown 2.90 inches and Halifax 1.80 inches. In the Western Provinces and in Ontario and Quebec the precipitation appears to have been almost entirely as snow.

TEMPERATURES FOR MONTH OF FEBRUARY, 1920

STATIONS	FEBRUARY	
	Highest	Lowest
Yukon		
Dawson	30	−56
British Columbia		
Atlin	41	−32
Agassiz	56	26
Barkerville	39	0
Kamloops	46	12
New Westminster	52	26
Prince Rupert	52	24
Vancouver	53	27
Victoria	53	32
Western Provinces		
Battleford	40	−26
Calgary	49	− 7
Edmonton	44	−18
Medicine Hat	44	− 5
Minnedosa	34	−34
Moosejaw	44	−22
Oakbank	32	−29
Portage la Prairie	—	—
Prince Albert	40	−30
Qu'Appelle	39	−30
Regina	38	−28
Saskatoon	38	−26
Souris	33	−32
Swift Current	40	−10
Winnipeg	32	−28
Ontario		
Agincourt	43	−16
Oak Ridges	41	−13
Bancroft	40	−31
Barrie	41	−16
Beatrice	39	−23
Bloomfield	36	−18
Brantford	46	−11
Chapleau	30	−40
Chatham	47	− 2
Clinton	42	−25
Collingwood	35	−15
Cottam	40	− 4
Georgetown	42	−11
Gravenhurst	41	−26
Grimsby	42	−17

STATIONS	FEBRUARY	
	Highest	Lowest
Ontario—continued		
Guelph	40	−12
Haliburton	40	−27
Huntsville	34	−33
Kenora	37	−29
Kingston	38	−18
Kitchener	43	−13
London	44	−18
Lucknow	39	−26
Oshawa	30	−10
Ottawa	35	−25
Paris	44	−19
Parry Sound	39	−20
Peterborough	44	−20
Port Arthur	35	−17
Port Burwell	39	−15
Port Dover	39	−15
Port Stanley	36	−16
Queensborough	38	−27
Ronville	43	−29
Southampton	37	−15
Stonecliffe	30	−26
Stoney Creek	44	−11
Toronto	46	− 9
Uxbridge	38	−23
Wallaceburg	34	—
Welland	44	−11
White River	28	−42
Quebec		
Brome	38	−43
Father Point	32	−20
Montreal	37	−21
Quebec	41	−27
Sherbrooke	39	−36
Maritime Provinces		
Charlottetown	44	−14
Chatham	40	−28
Fredericton	50	−20
Halifax	48	−14
Moncton	43	−17
St. John	43	−16
Sussex	49	−35
Sydney	50	−14
Yarmouth	48	− 4

EARTHQUAKE RECORDS BY MILNE SEISMOGRAPH, TORONTO

SIR FREDERIC STUPART, F.R.S.C., DIRECTOR

P.T.—Preliminary Tremors. S.—Secondary Waves. L.—Large Waves. A.C.—Air Currents. Time is Greenwich Mean Civil Time; it is to be given in hours, minutes and decimals of minutes; 0 or 24 h—midnight.

No.	Date 1920	P. T. Comm.	S. Comm.	L. W. Comm.	Max.	End	Max. Amp.	Remarks
	Feb.	h m s Gas out	h m s when other	h m s station reco	h m s rds quak	h m s e	mm.	
* 2101	" 2	11?40.8	11 52.5	12 10.2) 12 27.7)	12 38.1		7.3	11,030?Km.
2102	" 2	Merged	into 2101	13 31.9) 13 38.1)	13 41.2	Lost	2.8	Disastrous, reported from Prov. Minas Geraes, Brazil
2103	" 3			7 49.9	7 53.0	7 57.6	0.2	Gradual thickening. May not be seismic
2104	" 7			12 06.6	12 09.0	12 24.6	0.4	
2105	" 7			16 25.1	16 34.9		0.3	Thickenings
2106	" 7			16 52.7	16 55.3	17 10.7	0.1	Thickenings
2107	" 8			6 59.7	7 01.8	7 07.9	0.2	
2108	" 10			9 48.5	10 21.8		0.8	
2109	" 10			11 06.8	11 13.4	11 34.0	0.3	
2110	" 10			13 03.7		13 08.6	0.1	
2111	" 10	22 13.3	22 18.0	22 20.4	22 25.2	1 26.3	3.0	P well defined. Possibly West Indies. 2990 Km.
2112	" 12			0 31.1) 0 33.1)	0 44.2	1 15.2	0.2	
2113	" 15			15 47.1		15 50.5	0.05	May not be seismic
2114	" 20			12?37.2			0.05	Small micros going on
2115	" 22			17 54.0) 17 57.1)	Changing paper			
2116	" 28			16 04.4	16 07.1	16 12.2	0.2	Gradual thickening
2117	" 28			19 06.1) 19 10.9)		19 53.3	0.05	P. and S. not recorded

Period of Boom 18 seconds. Pillar inclination 1 mm =0″.45

*Numbers changed as small quake was previously left out on December 27th, 1919

EARTHQUAKE RECORDS BY MILNE SEISMOGRAPH, VICTORIA, B.C.

F. NAPIER DENISON, SUPERINTENDENT

No.	Date 1920	P. T. Comm.	S. Comm.	L. W. Comm.	Max.	End	Max. Amp.	Remarks
		h m s	h m s	h m s	h m s	h m s	mm.	
2090	Feb. 1	15?28 43			15 33 08	15?38 03	0.2	P may be L phase
2091	" 2	11 35 11	11 46 00	12 05 41	12 10 36	?	7.5	9790 Km.
2092	" 2	P & S merged into previous quake		13 45 31	13 48 57	16 07 39	4.0	Destructive. Minas Geraes, Brazil
2093	" 2	16 57 20			17 32 45	18 01 46	0.4	
2094	" 3	7?18 31			7 24 55	7 33 46	0.2	
2095	" 3	15?37 13			15 42 08	15 48 02	0.1	
2096	" 3	20?23 28			20 29 52	20?36 45	0.1	P may be L phase
2097	" 7	12?13 24		12 15 51	12 20 46	12 33 56	0.4	
2098	" 7	15?40 27		15 48 49	16 08 59	16 58 09	0.4	
2099	" 8	6?32 38		6 40 01	6 42 58		0.4	
2100	" 8	7 01 41		7 07 35	7 11 01	7 35 07	0.2	
2101	" 10	9 36 04	9 42 01	9 50 27	9 58 02	?	1.0	4180 Km.
2102	" 10				10 47 34	11 08 14	0.4	
2103	" 10	22 15 48	22 23 16	22 33 39	22 40 35	0 55 57	2.0	5850
2104	" 15			16 06 43	16 09 40	16 21 28	0.2	
2105	" 20		12 27 18	12 34 11	12 47 57	12 58 46	0.1	May be quake reported from Spain
2106	" 22	17 52 12	17 55 07	17 58 33	17 59 31	18 09 23	0.2	1720 Km.
2107	" 25	23 16 15	23 20 17	23 25 40	23 31 37	?	0.2	2460 Km.
2108	" 27	7 35 54			7 57 02		0.3	
2109	" 28	19 02 33		19 18 46	19 28 36		0.4	

Period of Boom 18 seconds. Pillar inclination 1 mm =0″.54

VERTICAL SEISMOGRAPH

Feb.	2	11 35 25	11 46 00	12 04 45	12 13 40	?	μ 70	9700 Km.
"	2				13 42 00		60	
"	10				22 40 00		6	

MAGNETIC DISTURBANCES, Jan., Feb., March, 1920.

No very noteworthy disturbances were recorded at Agincourt or Meanook during January and February. In March, however, two violent storms occurred.

The first storm began suddenly at 6h 39m, 75th M.T., March 4. The *H.F.* increased 27γ and then fell with small fluctuations to about normal or a little lower until 15 hours, when it commenced to rise, at first slowly, but after 17 hours very rapidly, passing above the limit of the photographic paper at 17h 29m and remaining off for 1h 5m. The force then diminished rapidly with large oscillatory movements passing off the negative side of the paper at 2h 18m March 5, for 16 minutes, after which it returned gradually to normal values. The range in *H* exceeded considerably 716γ, the limits of the paper, and is estimated to reach 950γ.

The Vertical Force trace was complete and showed very little departure from normal until 12h March 4, when the force increased slowly up to 16h, after which the increase was oscillatory and rapid reaching a maximum at 19h 55m of 239γ above normal, followed by a very rapid fall to 275γ below normal at 20h 51m, returning to about normal at 23h and slowly diminishing again to a second minimum of -270γ at 2h 12m March 5. It then gradually returned to normal during the morning of the 5th.

The Declination trace also remained about normal from the sudden beginning at 6h 39m until 17h, when oscillations of large amplitude set in which lasted until 22h. The maximum easterly swing was reached at 20h 53m and maximum westerly position at 21h 40m. The range in Declination amounted to $2^\circ 25'.6$. A smaller active period occurred from 2h to 4h of the 5th. This synchronized with the minimum value of *H* and the secondary minimum of *Z*.

The second storm was exceptionally violent and began suddenly on March 22 at 4h 9m. The *H.F.* first increased 52γ followed immediately by a decrease of 186γ and the storm was in full swing. *H* was carried off the negative side of the paper at 8h 25m and remained off until 11h 50m. The movement was very rapid at both disappearance and reappearance, and was observed to be beyond the limit of the eye-scale at 9h and 10h, which limit is 768γ below normal. Very rapid oscillations of moderate amplitude occurred about the normal position of *H* from 13h to 18h. At 18h the Force increased very rapidly passing the upper limit of the record, $+334\gamma$, at 18h 11m and remaining off the paper for 25 minutes. The Force held above normal until 20h 20m when it passed rapidly to subnormal values, again going off the negative side of the paper at 22h. From 22h to 4h of the 23rd it was off the negative side of the paper about half the time. The *H* continued moderately disturbed until midnight of the 24th. The extreme range in *H* was in excess of 1100γ and is estimated to have reached at least 1200γ.

The Vertical Force trace was complete except for a few minutes. From commencement to 12h on the 22nd it was below normal, from 12h to 18h was slightly above normal. Following 18h, large variations took place in very short time intervals. Exceptionally large movements occurred at 18h 30m, 22h 3m, 22h 12m, 22h 40m, 22h 58m, 23h 12m, and 23h 27m on the 22nd and 0h 17m of

the 23rd. During this period of violent disturbance the *Z* was on the average above normal. After 4h of the 23rd it returned to about normal values but was still disturbed with subnormal values during the night hours of the 23rd and 24th. The range in *Z* was in excess of 800γ and is estimated at about 1000γ.

The Declination curve shows maximum disturbance synchronizing with that of *H* and *Z*. In the Declination the tendency was to carry the needle to the west. The west limit of the paper was passed on four occasions, at 8h 49m; 22h 0m, 22h 52m and 23h 19m of the 22nd. The maximum easterly position, 44′ east of normal, was reached at 13h 31m of the 22nd. The *W* limit of the paper is 90′ west of normal. The range, therefore, exceeded 134′ and probably reached 3°. The Meanook *D* curve synchronized with the Agincourt Declination so far as periods of intense disturbance was concerned but the amplitudes of the variations were very much in excess of those recorded at Agincourt. The amplitudes were particularly large from 8h to 14h 75th M.T. March 22, and from 20h March 22 until 5h March 23. The range was greatly in excess of the limit of the paper which was 4° 24′ and probably reached 5°.

This storm was coincident with the appearance of a very extensive sun spot group immediately south of the sun's centre and which passed the central meridian on the 22nd. A wonderfully beautiful and active aurora was observed on the night of the 22nd over the greater part of the Northern Hemisphere.

Owing to unfavourable weather, no obesrvations were made on the sun from March 3 to 10. On the 3rd only a small spot was visible, but on the 10th a large area north of the equator gave evidence of having been greatly disturbed during this interval, and a large group of small spots were visible, which would have crossed the central meridian about the 5th or at about the time of the earlier magnetic storm.

NOTES AND QUERIES

Communications are Invited, Especially from Amateurs. The Editor will try to Secure Answers to Queries

THE DEATH OF DR. JOHN A. BRASHEAR

It would be hard to name one whose passing away would be more felt than that of John Alfred Brashear, which occurred at his home in Pittsburgh, April 9th, 1920.

With astronomers and other scientific men throughout the world he had not only business connections but also friendly relations, and a very wide circle of people in all walks of life looked up to him with genuine affection. In a succeeding number of the JOURNAL will appear an account of his life, written by a member of the staff of the Allegheny Observatory; but here the present writer wishes to make a few local and personal references.

For many years Dr. Brashear spent the summer months at his cottage on "Isle Urania", in Lake Muskoka, and his flitting back and forth through Toronto led to many friendships in this part of the country, especially with members of the Royal Astronomical Society. On May 28th, 1899, he spoke at an evening meeting on "Diffraction Gratings", describing the experiences of Rowland and himself; and at the close he presented to the Society a fine specimen of his handiwork. Two years later, in 1901, he was elected an Honorary Fellow. On February 6th, 1912, he again addressed the Society, his subject being, "The Making of Giant Telescopes, and What they will do". In both cases his lectures were well supplied with interesting personal experiences.

In Muskoka and the neighbouring part of the country he was in great demand to speak for charitable or educational purposes, and, during the war, for Red Cross funds. Indeed he always was looking for the one who needed cheering and assistance. Probably the last

occasion when he spent any length of time in Toronto was towards the end of 1918. He was looking into our method of re-educating and training the returned soldiers, and the interviews which were printed in the Pittsburgh papers after his return showed how interested and appreciative he was.

It may be fitting to close with an extract from a letter addressed to the writer, dated February 24th, 1920. It is very personal and was never intended to be given publicity, but it shows that, though Dr. Brashear was very weak, his mind was active and his sympathy constant for his friends:

> Doctors and family have put the ban on my writing letters, but now and then I steal a chance and *break the rules* laid down for me.
>
> I've had a pretty hard twelve months of it, the first for half a century. Just this time, a year ago, I was caught by the "flu", which held me a captive for nine weeks, and I had to have both ears operated upon to save me from mastoid trouble and total deafness.
>
> I skipped off to my cottage in Muskoka, stayed three or four weeks, returned feeling better and was just getting ready to attend to the various commencements when I was seized by a violent attack of ptomaine poisoning that came near sending me over to star-land without the use of a telescope. After about a month I felt well enough to go to Muskoka, going by easy stages, and I did not return until the second week in October. Got on nicely until the middle of November, when, on a visit to Cleveland, I caught cold riding in an auto, and here I am, not over it yet, seemingly nothing particularly wrong except extreme weakness.
>
> I am hoping, however, that when this miserable winter weather is ended and I can get out into the sunshine I may come to myself again, for oh! there is so much for me to do in this educational work, [Henry C. Frick Educational Commission, of which he was President] and now that Mr. Frick has given my commission ten times as much as we have had to use the past nine years. I only wish I was twenty-five years younger, so that I might do my share in the great work—instead of sailing onward to my eightieth mile-stone.
>
> But added to my burden was the loss of my eldest brother and my grandson within the last ten days—both from pneumonia. The grandson and his good wife have lived with us for seventeen years, and so we miss him greatly. His dear wife has been a "wingless angel" to me since my own dear companion left me for the "summer-land of song" nine years ago.
>
> But I did not start out to tell you all this unfortunate experience of your friend, but to write you on another subject entirely. For several years I have been taking the UNIVERSITY MAGAZINE, which, no doubt, you are well acquainted with. In the December number of the magazine the leading article was by Sir Andrew MacPhail, on the schools of Ontario, which I thought one of the most unkindly and uncalled for attacks I ever read or heard of. I could hardly

believe such a criticism could come from Sir Andrew, and especially when he compared the Ontario public schools with those of Quebec. I know the public schools are open to criticism, especially the *rural* schools, but they do not deserve such scathing language as he uses in that article. I have for many years been interested in your common and high schools, and have visited many of them when I could get to Canada early enough or stay long enough until they started in their autumn sessions; and it has been my practice not only to visit the Summer School for Teachers at Bracebridge, but also to give them lectures, by request of their teachers and the school inspectors, and it has given me great pleasure to do so.

ECLIPSE OF ONE SATELLITE OF JUPITER BY ANOTHER

(*Communicated*)

At precisely ten o'clock on Monday evening, April 19, 1920, there occurred an eclipse of one of Jupiter's satellites by another of them. Watching the Jovian system in a 9½ inch reflecting telescope a little previously it was noticed that the two satellites following the planet were so close together as to be mistaken for a single point of light. A slight uncertainty in the object caused closer inspection to be made. The power at that time which was being used was about 100. On more careful observation it seemed as if there might be two points of light at the place in question instead of only one. A power of about 210 was hastily substituted for the lower power eyepiece, and an examination made, when it was very evident that there were two satellites in extremely close association. A comparison was made, and it was observed that the two satellites were closer together than the component stars in Gamma Virginis, which are about 7 seconds of arc asunder, and perhaps as close together as the stars which form Castor, and which are about five seconds of arc apart. On returning the telescope to view Jupiter's satellites again they had even still closer approximated, and with the power then in use—the power of about 210 diameters—it was impossible to regard the satellites as distinct bodies. A still higher power was employed, this time about 320, and then 450, when the satellites could be just detected individually. Closer still they crept, and just as the City Hall clock of Toronto boomed out the hour of ten o'clock, it was no longer possible to regard the two objects as other than one. A little delay here occurred and the next observation was made at about 5 or 6 minutes past ten o'clock, when the two satellites were seen separately. After this they began to widen with some rapidity. At fifteen minutes past ten o'clock they were about five seconds of arc apart, and by half past ten o'clock they were easily one-third the planet's diameter apart, or in other words, possibly ten seconds of arc separated. During this time these satellites, one of which undoubtedly eclipsed the other on this occasion, were

about three and a half or four diameters of the planet following the parent orb. On consulting the HANDBOOK of the Royal Astronomical Society it was observed that these satellites were numbers one and three. Satellite number one has, of course, a very rapid motion around the ball of the planet, and in consequence changes its location very rapidly. During the forty minutes or so, during which these two satellites were under observation, satellite number one must have moved through possibly eighteen or twenty seconds of arc. The other satellite, of course, was moving also, but its motion was very slow compared with its more speedy brother. Often satellites of Jupiter are observed to be very close together and to separate with some rapidity, but seldom do they draw so near as to appear to actually merge in one, as they did upon this occasion. The view presented while of course of exceedingly minor importance was not without interest, while to an amateur, as the present observer is, was unquestionably so.

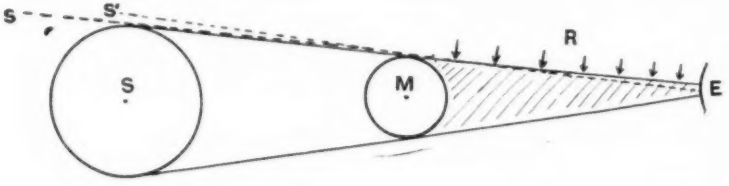
ALBERT R. HASSARD.

Toronto, April 22, 1920.

THE SOLAR ECLIPSE AND RELATIVITY

(*Communicated*)

In the diagram *S*, *M*, *E* represent the relative positions of the sun, moon and earth during a total solar eclipse. The diagram is not to scale. The shaded portion of the figure represents the cone of the umbra. All the space between the moon and the earth outside this cone is bathed with sunlight. The dotted line from *S* represents a ray of starlight which passes close to the surfaces of the sun and the moon and enters the umbral cone, finally reaching an observer on the earth. On the Ernstein theory this ray, while passing close to the sun, is



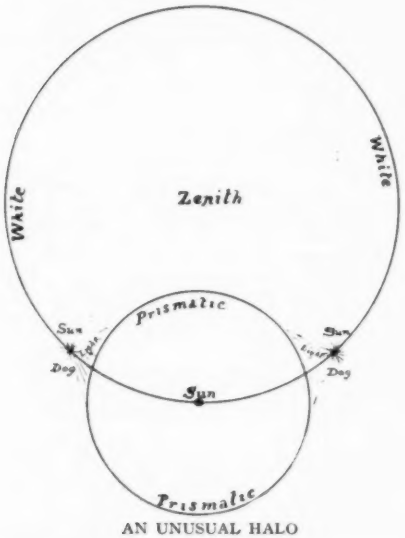
attracted towards it and thus to an observer on the earth the star appears displaced away from the sun. I propose another hypothesis. We know that light (or radiation) exerts pressure, the pressure being proportional to the energy in

the beam. If the beam falls normally on a surface which totally absorbs it the pressure is numerically equal to the energy per cubic centimetre. If the incidence is oblique the normal pressure is less than before and there is now also a tangential force acting on the surface. These forces have been experimentally determined by many physicists and the numerical results have been convincing. Let us take up for a moment an analogous problem in electricity. Suppose we have an electrical condenser consisting of two parallel metal plates. When the con lenser is charged we imagine lines of force to reach from one plate to the other. The two plates are pulled together by the electrical forces, and it can be shown that the resulting forces can be imitated by imagining that the lines or tubes of force are in tension. The pull on unit area of one plate is equal to the energy per unit volume of the medium between the plates. The lines of forces also apparently repel one another so that at the boundary of the electric field between the plates the lines or tubes swell and curve out into the space outside the geometrical volume between the charged plates.

Now is it possible that the so-called "rays" of light behave much in the same way? Consider again the ray from the star S. It continues its path through a region full of sunlight until it passes through the surface of the umbral cone.

For the rest of its path *i.e.*, from M to E, it is travelling just within the umbral cone and in such a way that on one side of it (the lower side in the diagram) there are no rays of light while on the other side (the upper side in the diagram) the space is filled with sunlight. Is it possible then that it may behave as if it were repelled by the other rays of light or in other words that there is some kind of a radiation pressure on it as indicated by the arrows marked R in the diagram? This repulsion or pressure, whatever it is, may cause the starlight to deviate from a straight course and to bend downwards by a small amount (too small to show up clearly in the figure) so that the actual path is along the dotted line between M and E. An observer on the earth thus sees the star not in its true position S but in a position S'. In other words the star is apparently displaced away from the sun (or the moon). If this hypothesis is worth following up some theory may be built up to enable the deviation of the light as it passes down near the surface of the umbral cone to be calculated. The deviation would depend on the distance between the ray and the surface of the umbral cone and on the time of passage from the moon to the earth. If the radiation pressure were uniform the path would be parabolic and the apparent position of the star would be along the tangent to the part of the parabola just before this reaches the earth.

JOHN SATTERLY.



AN UNUSUAL HALO

Mr. Peter McArthur, of Ekfrid, Ont., in the Toronto *Globe* of April 7, described an unusual solar halo observed at that place by him on Saturday, April 3rd. The halo around the sun (primary circle) "was of unusual brightness, having prismatic effects at the top and bottom and sundogs at either side. The sundogs were attached to the halo by curved tangent lines from above and below, making curvilinear triangles. These triangles were full of glowing light. The sky inside of the halo was very dark—almost black, with a suggestion of purple. . . . The halo around the sun was cut by a white halo that had the zenith as its centre and circled around the whole sky. It seemed to be about parallel with the horizon at the altitude of the sun."

From the above description, and also from a drawing reproduced herewith, it would seem that, in the tangent lines attaching the sundogs to the halo, there was a unique example of the Oblique arcs of Lowitz, described in the treatises as very rare phenomena.

C. A. C.

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